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out of cultivation. Mr. Middleton states that the chief immediate cause of the increased productivity of German soil is the increase in use of artificial manures; twice as much nitrogen, one third more phosphate, and five times as much potash are used in Germany as on an equal area of our cultivated land. The reason Mr. Middleton gives for this failure of the British farmer is want of education, but he thinks that this defect in our educational system is being remedied. There are, however, undoubtedly other causes, which might more quickly be removed, for the depression which has affected British agriculture during the last seventy and especially the last thirty or forty years.—*British Medical Journal*.

SCIENTIFIC BOOKS

An Introduction to the Study of Color Vision.

By J. HERBERT PARSONS, D.Sc., F.R.C.S., Ophthalmic Surgeon, University College Hospital; Surgeon, Royal London Ophthalmic Hospital. Cambridge, University Press. 1915. 308 pp.

Dr. Parsons has undertaken to present the facts and the theories of color vision in such form as shall be intelligible to the general reader. He states in his preface:

The vast literature on color vision consists almost entirely of papers written in support of some particular theory. It is peculiarly difficult to obtain a general and unbiased view of the subject. I have here endeavored to separate the best established facts of color vision from the theories, and have then discussed the chief theories in the light of these facts.

Accordingly he has divided his book into three parts. The first part (pp. 1-157) is devoted to a statement of the facts of normal color vision; the second part (pp. 158-192) deals with the facts of color-blindness; and the remaining portion (pp. 193-299) discusses theories of color vision.

The author's statement of the facts of normal color vision is prefaced by a brief summary of such phenomena of physical optics and such a description of the structure and function of the visual organ as shall serve as a basis for his subsequent discussion. This

is followed by a description of the color vision of the light-adapted eye and of the dark-adapted eye, together with a summary of the temporal and spatial effects of retinal stimulation (after-images, contrast, color-zones and the like). His chapter on the evolution of the color-sense presents evidence derived from the color vision of the lower animals, from the color vision of primitive peoples, and from the color vision of infants. The description of color-blindness summarizes the findings obtained in various investigations of certain typical deviations from normal color vision. The chapters on theories of color vision are prefaced by an historical sketch of the development of color theories, and this is followed by a summary statement of the most widely accepted theories.

Dr. Parsons has attempted a difficult task in his endeavor to present a readable summary of the exceedingly voluminous and exceedingly controversial literature of color vision; and his book bears evidence of painstaking effort and keen insight. The author has exercised sound judgment in selecting and presenting his material; and for the most part he has maintained an admirably non-partisan attitude throughout—except, perhaps, in dealing with the duplicity theory where his approval is more complete than the facts seem to the reviewer to warrant. The features in Dr. Parsons's book which are most likely to excite criticism are the author's tendency toward an uncritical statement of the findings of the various investigators, and his failure to recapitulate his mass of summaries and to give the reader a brief statement of the present status of the various problems. There is perhaps no field of investigation in which the refinement of apparatus and of technique has made greater progress within the past decade or two than in the field of color vision; it follows, therefore, that many of the earlier investigations now possess no more than historical value. It seems to the reviewer to be doubtful wisdom to lump together the findings of good, bad and indifferent investigations, and to present them to the reader without any attempt at critical evaluation. In several instances the

author has employed a loose form of statement—for instance, he speaks of “physiological sensations” (p. 162), and he employs the term color throughout in an equivocal and confusing fashion, sometimes referring to color-stimulus and sometimes to color-sensation; a few inaccuracies of statement are also to be found, of which perhaps the most serious is the assertion that the extreme peripheral region of the retina is totally color-blind (p. 71; p. 258). Although the book will be of doubtful service to elementary students, it may safely be recommended to more advanced workers as a supplement to the earlier and more critical summaries by Mrs. Ladd-Franklin and others in Baldwin’s “Dictionary,” and by Rivers in Schäfer’s “Text-Book of Physiology.”

J. W. BAIRD

CLARK UNIVERSITY

SPECIAL ARTICLES

THE MAMMALIAN ERYTHROCYTE—A BICONCAVE DISC¹

THE existence of “bell”- or “cup”-shaped red corpuscles in mammalian blood has been recorded frequently since the early observations of Leeuwenhoek (1719).² The serious proposal that the cup, and not the classic biconcave disc, is to be considered normal is, however, a comparatively recent teaching which has been received with considerable skepticism. Since these concavo-convex corpuscles may be found in drawn blood, in fixed tissues, and even in circulating blood, the issue obviously hinges on the determination of which is the normal and which the derived form—one or the other representing a modification.

1. *Examination of Drawn Blood.*—It has been claimed (Weidenreich, '02,³ et seq.; Lewis '04)⁴ that drawn blood examined im-

mediately on a warm slide is favorable for the demonstration of cups. According to this view, the assumption of the familiar disc-shape depends on an almost instantaneous change due to the evaporation and concentration of plasma before the preparation can be made and examined.

That the disc-form is normal has been asserted by Jordan ('15)⁵ working with blood, diluted with physiological solutions, in culture slides, and by Löhner ('10)⁶ who employed a cabinet of sufficient size to contain a microscope and to permit the free use of his hands, introduced through appropriate openings. Within this apparatus, heated to 38° C. and saturated with moisture, blood was drawn from the finger and examined. Löhner reports that the blood corpuscles were “stets und ausschliesslich” biconcave discs.

In ordinary warm slide- and cover-preparations, made as quickly as possible, I have observed a few cups only, but have never followed the transformation of these into discs as the newer hypothesis suggests. The momentary exposure to air necessitated in making ordinary preparations may be practically eliminated by utilizing the following method. Superimposed cover glasses, separated by a hair, are fused at one point by heat; if an edge be now applied to a needle prick in the finger, and the finger squeezed, the issuing blood is drawn in by capillarity. Such preparations, examined quickly, have never yielded evidence for the general existence of the cup-shape. A few cups may usually be found, whereas scores of indubitable discs appear.

Since the experiments of Ranvier, in 1875,⁷ it has been known that graded temperatures can alter disc-shaped corpuscles to shallow cups, thick-walled cups or even to spheres—*e. g.*, typical cups are found exclusively when blood is warmed to 55° C. (Zoth).⁸ Is it possible that some investigators, who advocate the

¹ From the Anatomical Laboratory of the Northwestern University Medical School, Contribution No. 43, July 2, 1916.

² Leeuwenhoek, A., “*Epistolæ physiologicæ*,” *epistola* 44, 1719.

³ Weidenreich, F., *Arch. f. mik. Anat.*, Bd. 61, pp. 459–507, 1902.

⁴ Lewis, F. T., *Jour. Med. Research*, Vol. 10 (N. S., 5), pp. 513–517, 1904.

⁵ Jordan, H. E., *Proc. Soc. Exp. Biol. and Med.*, Vol. 12, No. 7, pp. 167–169, 1915.

⁶ Löhner, L., *Arch. f. gesam. Physiol.*, Bd. 131, pp. 408–424, 1910.

⁷ Ranvier, L., “*Traité technique d’Histologie*,” 1st ed., Paris, 1875.

⁸ Zoth. Vide Löhner, *op. cit.*